Thermo Power Corp.
(Tecogen Division)

# On-Line, Real-Time Alpha Radiation Measuring Instrument

## Technology Need:

The Department of Energy (DOE) must ensure that effluent waters leaving contaminated DOE sites do not affect the public's safety or health. Alpha-emitting radioisotopes, such as Uranium-238 ($^{238}$U), Uranium-234 ($^{234}$U) and Plutonium-239 ($^{239}$Pu), are rated by the U.S. EPA as class A carcinogens with very low regulated limits in water. Uranium (U) also has a high chemical toxicity. The EPA proposed maximum concentration limit for uranium in public drinking water supplies is 20 parts per billion (ppb) (30 picoCuries per liter [pCi/l]), equivalent to an emission of 58 alphas per minute in 1 liter of water. For reference, the world's sea water has a uniform U concentration of 3.3 ppb.

Currently, surface and ground waters at contaminated DOE sites are monitored for alpha emitters (and other contaminants) by intermittent sampling, with analysis at a central laboratory. Principal shortcomings of the current approach are:

- Spikes in radionuclides may not be detected
- High end-to-end total costs
- Long time delay between sampling and data availability
- Prone to errors and mistakes due to the multiple handling and processing steps involved
- Requires expensive archiving of samples.

**Thermo Alpha Monitor (TAM)**

## Technology Description:

Thermo Power Corporation has demonstrated a new technology which permits extremely sensitive counting of alpha emitters in water, providing high-resolution alpha spectrometry. Individual radionuclides can be assayed simultaneously, based on their different alpha energies. This new technology provides the basis for an on-line, real-time monitor of alpha-emitting radionuclides, both for effluent streams leaving DOE sites and for process streams.

The technology involves a patent-pending, in situ method of collecting and concentrating dissolved radioactive species on a solid surface, allowing for rapid quantification of the specific alpha-emitting species with a solid-state silicon detector. Initial development of this

technique involved simultaneous collection and quantification of the radioisotopes directly on the silicon detector, providing an energy resolution equivalent to conventional electroplating techniques. This technology has been proven with laboratory and field tests, with both naturally-occurring and transuranic alpha emitters.

Alternative implementations of this technology are being developed, in order to extend the detection limits well below the existing picoCurie per liter range, improving the response time of the technique, and providing an archival record of the analyzed sample.

## Benefits:

*Advantages of using the Thermo Alpha Monitor (TAM) include:*

<Rapid and accurate analyses

<Dramatic reduction in end-to-end monitoring costs

<Results can be automatically archived electronically

*Capabilities of the TAM include:*

<Isotopic analyses, allowing discrimination of naturally-occurring radionuclides (radon daughters)

<Capable of analyzing waste and process water (National Pollution Discharge Elimination System [NPDES]) discharges

<Surface and ground water monitoring, with future extension to solid samples, non-aqueous liquids, gas streams, and solid surfaces

## Status and Accomplishments:

Field testing of the TAM was conducted at several locations within the Oak Ridge National Laboratory (ORNL). Tests were conducted to evaluate the response of the instrument to a range of water chemistries, contaminant concentrations, and radioisotopes. Tests were conducted utilizing surface, ground, and process waters to detect alpha emitters, primarily uranium, in a "near real time," automated mode. Waters tested included the waste water treatment plant influent and effluent, the East Fork of Poplar Creek, a surface water site and a groundwater monitoring well. Samples ranged from less than 10 ppb to about 100 ppb of uranium.

The TAM was successfully demonstrated on water 100 times below the EPA's proposed safe drinking water limit - down to under 1 picoCurie per liter (pCi/l). The instrument analyzed isotopic U levels on samples from five sites. The demonstration extended the isotopic detection limit of the TAM to 10 parts per trillion (ppt) natural U (15 femtoCuries per liter fCi/l]). In addition, the technology responded to 20 ppb natural U (30 pCi/l) in under 30 minutes.

During Feburary 2001, NETL was informed that Thermo Technologies, a subsidiary of Thermopower, was being eliminated. Due to these developments, the TAM has been transferred to the radioactive liquid waste treatment facility at Los Alamos National Laboratory (LANL) where they will use the instrument in everyday operation.

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## Online Resources

Office of Science and Technology, Technology Management System (TMS), Tech ID # 312
http://ost.em.doe.gov/tms

The National Energy Technology Laboratory Internet address is http://www.netl.doe.gov

An Innovative Technology Summary Report (ITSR) is available for this technology on the OST website at http://ost.em.doe.gov/ifd/scfa/itsrs/itsr312/itsr312.pdf